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(54) **HAIR COMPOSITION WITH IMPROVED RHEOLOGY**

(71) Applicant: **Conopco, Inc.**, Englewood Cliffs, NJ (US)

(72) Inventors: **Frederic Jean-Michel Blondel**, Lezigneux (FR); **Christopher John Roberts**, Bebington (GB)

(73) Assignee: **Conopco, Inc.**, Englewood Cliffs, NJ (US)

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(58) **Field of Classification Search**

None

See application file for complete search history.

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Primary Examiner — Robert A Wax

Assistant Examiner — Caralynne Helm

(74) *Attorney, Agent, or Firm* — Karen E. Klumas

(57) **ABSTRACT**

A hair treatment composition comprising a thickener which comprises a copolymer derived from the polymerization of at least a non-ionic monomer (a) and at least a cationic monomer (b).

14 Claims, No Drawings

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HAIR COMPOSITION WITH IMPROVED RHEOLOGY

The present invention relates to a hair treatment composition with improved rheology.

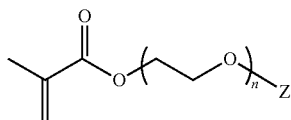
Conditioning compositions typically comprise rheology modifiers to maintain good sensorial properties during application. An example is Tinovis CD® which is commercially available from BASF.

Low pH formulations offer enhanced claims for internal repair of damaged hair fibres. Unfortunately, this aspect of hair fibre repair treatment is not possible from compositions comprising the standard rheology modifier Tinovis CD® since the polymer is sensitive to increased levels of electrolyte. The sensitivity manifests itself as a drop in viscosity which has a detrimental effect on the quality of the product.

Accordingly, there remains a need for leave on treatments with improved rheology. The present invention, therefore, provides a hair treatment composition comprising a thickener which comprises a co-polymer derived from the polymerization of at least a non-ionic monomer (a) and at least a cationic monomer (b), wherein the non-ionic monomer (a) is selected from the group consisting of methacrylamide, N-isopropylacrylamide, N-methylolacrylamide, N-vinylformamide, N-vinylpyridine, N-vinylpyrrolidone, 2-hydroxyethylacrylate, poly(ethylene glycol) acrylate, and/or poly(ethylene glycol) methacrylate.

Preferably the non-ionic monomer (a) is poly(ethylene glycol) acrylate, and/or poly(ethylene glycol) methacrylate.

Most preferably, the non-ionic monomer (a) is PEG-methacrylate of the following structure corresponding to Formula I.

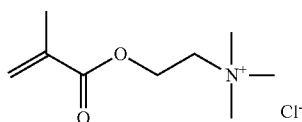


n is from 1 to 250 and Z is H or an alkyl group with 1 to 5 carbon atoms.

The cationic monomer (b) is selected from the group consisting of acryloyloxyethyltrialkylammonium and/or methacryloyloxyethyltrialkylammonium, quaternized or salified, diallyldimethyl ammonium chloride, acrylamidopropyltrimethylammonium chloride, and/or methacrylamidopropyltrimethylammonium chloride.

Preferably, the cationic monomer (b) is acryloyloxyethyltrialkylammonium and/or methacryloyloxyethyltrialkylammonium, quaternized or salified.

Most preferably, the cationic monomer (b) is methacryloyloxyethyltrialkylammonium salt of the following formula (II)



Preferably, non-ionic monomer represents from 0.1 to 15 mol % of the polymer, without taking into account the crosslinking agent or the chain transfer agent.

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Preferably, the cationic monomer represents from 85 to 99.9 mol % of the polymer, without taking into account the crosslinking agent or the chain transfer agent.

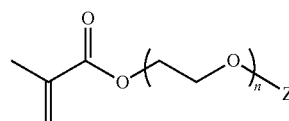
Preferably, the polymer is crosslinked with an amount of crosslinking agent comprises between 50 to 5,000 ppm in weight based on the total amount of cationic and non-ionic monomers.

The crosslinking agent is selected from the group comprising methylene bisacrylamide (MBA), ethylene glycol diacrylate, polyethylene glycol dimethacrylate, diacrylamide, cyanomethylacrylate, vinylxyethylacrylate or methacrylate, triallylamine, formaldehyde, glyoxal, compounds of the glycidylether type such as ethyleneglycol diglycidylether, or epoxy.

A chain transfer agent may be used in the polymerization of the co-polymer of the invention. The chain transfer agent is preferably selected from the group comprising phosphate-type chain transfer agents, such as sodium hypophosphite, lower alcohols, such as methanol or isopropanol, thiol based chain transfer agent, such as 2-mercaptoethanol and mixtures of the foregoing agents.

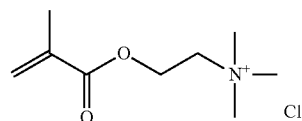
A preferred embodiment of the present invention is a copolymer derived from the polymerization of

- (a) 0.1 to 15 mol % of PEG-methacrylate of the following structure corresponding to Formula I.



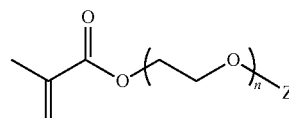
n is from 1 to 250 and Z is H or an alkyl group with 1 to 5 carbon atoms. And

- (b) 85 to 99.9 mol % of methacryloyloxyethyltrialkylammonium salt of the following formula (II)



A more preferred embodiment of the present invention is a copolymer derived from the polymerization of

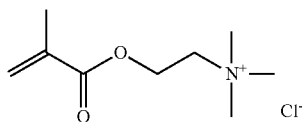
- (a) 0.1 to 15 mol % of PEG-methacrylate of the following structure corresponding to Formula I.



n is from 1 to 250 and Z is H or an alkyl group with 1 to 5 carbon atoms. And

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- (b) 85 to 99.9 mol % of methacryloyloxyethyltrialkylammonium salt of the following formula (II)



And

- (c) 50 to 5,000 ppm (based on the total amount of non-ionic and cationic monomers) of crosslinking agent.

According to the invention, the water-soluble polymers used do not require the development of a particular polymerization method. They can be obtained by all polymerization techniques well known to a person skilled in the art (solution polymerization, suspension polymerization, gel polymerization, precipitation polymerization, emulsion polymerization (aqueous or reverse) followed or not by a spray drying step, suspension polymerization, micellar polymerization followed or not by a precipitation step).

According to one advantageous aspect of the invention, the polymer is made by reverse phase polymerisation for instance as is described generally in U.S. Pat. No. 4,059,552.

An inverse emulsion polymerization process usually comprises the following steps:

- A) forming a water-in-oil emulsion of an aqueous solution containing the monomers and/or the crosslinking agent and/or the transfer agent and an emulsifying agent, wherein said emulsifying agent preferably should have an HLB value in the range of 3 to 8 and more preferably in the range of 4 to 6, in a hydrophobic phase, like an oil selected from the group comprising mineral oils, synthetic oils, vegetable oils, silicone oils and mixtures thereof;
- and B) polymerizing said monomers to form a polymer emulsion, optionally, by using a free radical generating catalyst to initiate the reaction, and controlling the temperature of the reaction mixture.

The resulting inverse emulsion polymer composition according to the present invention may have an active polymer concentration of about 25 to about 75% by weight.

The inverse emulsion composition according to the present invention may further comprise an inverting surfactant in a concentration of up to about 5 weight percent. The inverting surfactant may improve the polymer's dissolution in water. Suitable inverting surfactants are those with an HLB of at least about 10, preferably 10 to 20, with an HLB of about 10 to about 15 being most preferred. Especially suitable are the non-ionic inverting surfactants. Typical "inverting agents" include fatty alcohol ethoxylates, fatty acid esters-sorbitanpoly ethylene glycols-glycerol, alkyl polyglucosides, etc. Certain silicone compounds such as dimethicone copolyols can also be used.

According to the present invention, it is also possible to concentrate (by heating under vacuum to remove excess water and organic solvent by distillation) or to isolate the polymer by all known techniques. In particular, there are many processes for obtaining a powder on the basis of soluble polymer emulsions or ones which swell in water. These processes involve the isolation of the active matter from other constituents of the emulsion. Such processes include: precipitation in a non-solvent medium such as acetone, methanol, and other polar solvents: simple filtration then permits isolation of the polymer particle, azeotropic distillation in the presence of an agglomerating agent and stabilizing polymer

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which makes it possible to obtain agglomerates which are easily isolated by filtration before drying of the particle is undertaken, "Spray drying", or drying by atomization or pulverization, which consists of creating a cloud of fine droplets of emulsion in a stream of hot air for a controlled period.

While the present invention has been described with respect to specific embodiments thereof, it will be recognized by those of ordinary skill in the art that many modifications, enhancements, and/or changes can be achieved without departing from the spirit and scope of the invention.

Preferably, the composition comprises from 0.01 to 5% wt. of the composition, more preferably from 0.1 to 1% and most preferably from 0.15 to 0.3% wt. of the composition.

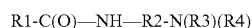
The compositions according to the invention are preferably leave-on conditioning compositions. By conditioning composition is meant compositions which have as their primary object conditioning keratinous fibre, such as hair, as opposed to compositions which have as their primary aim cleansing the hair while providing a conditioning benefit. Accordingly, it is preferred that the composition comprises less than 5% wt. anionic surfactant, more preferably less than 5% wt. cleansing surfactant. More preferably, the composition comprises less than 3% wt. anionic surfactant, still more preferably less than 3% wt. cleansing surfactant and especially preferably no anionic surfactant.

By leave-on composition is meant that the composition is applied to the hair and not rinsed-off. Typically, this is applied to the hair before the user goes to bed at night.

The composition according to the invention comprises from 0.001 to 5% wt. conditioning active, more preferably from 0.1 to 4.0% by wt. conditioning active.

Preferably, the composition comprises a conditioning active selected from acid neutralized amidoamine surfactant, fatty alcohols and conditioning silicones.

Preferably, the acid neutralized amidoamine surfactant is of general formula:



wherein R1 is a fatty acid chain with from 12 to 22 carbon atoms, R2 is an alkylene group containing from one to 4 carbon atoms and R3 and R4 are, independently, an alkyl group having from one to four carbon atoms.

Preferably, the acid neutralized amidoamine surfactant is selected from stearamidopropyl dimethylamine, stearamidopropyl diethylamine, stearamidoethyl dimethylamine, stearamidoethyl diethylamine, palmitamidopropyl dimethylamine, behenamidopropyl dimethylamine, myristamidopropyl dimethylamine, oleoamidopropyl dimethylamine, ricinoleoamidopropyl dimethylamine and mixtures.

Preferably, the composition according to the invention comprises less than 0.5% wt. cationic surfactant. More preferably, the composition according to the invention comprises less than 0.2% wt. cationic surfactant.

Preferably, the composition according to the invention comprises less than 0.5% wt. and more preferably less than 0.2% wt. a cationic surfactant selected from cetyltrimethylammonium chloride, behenyltrimethylammonium chloride, cetylpyridinium chloride, tetramethylammonium chloride, tetraethylammonium chloride, octyltrimethylammonium chloride, dodecyltrimethylammonium chloride, hexadecyltrimethylammonium chloride, octyldimethylbenzylammonium chloride, decyldimethylbenzylammonium chloride, stearyldimethylbenzylammonium chloride, didodecyldimethylammonium chloride, dioctadecyldimethylammonium chloride, tallowtrimethylammonium chloride, cocotrimethylammonium chloride, and the corresponding hydroxides thereof. Further suitable cationic surfactants include those

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materials having the CTFA designations Quaternium-5, Quaternium-31 and Quaternium-18.

Conditioners of the invention advantageously incorporate a fatty alcohol material. The combined use of fatty alcohol materials and cationic surfactants in conditioning compositions is believed to be especially advantageous, because this leads to the formation of a lamellar phase, in which the cationic surfactant is dispersed.

Representative fatty alcohols comprise from 8 to 22 carbon atoms, more preferably 16 to 20. Examples of suitable fatty alcohols include cetyl alcohol, stearyl alcohol and mixtures thereof. The use of these materials is also advantageous in that they contribute to the overall conditioning properties of compositions of the invention.

The level of fatty alcohol material in conditioners of the invention is conveniently from 0.01 to 5%, preferably from 0.1 to 3% by weight of the composition.

Silicone is a particularly preferred ingredient in hair treatment compositions of the invention. In particular, conditioners of the invention will preferably also comprise emulsified particles of silicone, for enhancing conditioning performance. The silicone is insoluble in the aqueous matrix of the composition and so is present in an emulsified form, with the silicone present as dispersed particles.

Suitable silicones include polydiorganosiloxanes, in particular polydimethylsiloxanes which have the CTFA designation dimethicone. Also suitable for use compositions of the invention are polydimethyl siloxanes having hydroxyl end groups, which have the CTFA designation dimethiconol. Also suitable for use in compositions of the invention are silicone gums having a slight degree of cross-linking, as are described for example in WO 96/31188. These materials can impart body, volume and stylability to hair, as well as good wet and dry conditioning.

The viscosity of the emulsified silicone itself (not the emulsion or the final hair conditioning composition) is typically at least 10,000 cst. In general we have found that conditioning performance increases with increased viscosity. Accordingly, the viscosity of the silicone itself is preferably at least 60,000 cst, most preferably at least 500,000 cst, ideally at least 1,000,000 cst. Preferably the viscosity does not exceed 10^9 cst for ease of formulation.

Emulsified silicones for use in conditioners of the invention will typically have an average silicone particle size in the composition of less than 30, preferably less than 20, more preferably less than 10 microns. We have found that reducing the particle size generally improves conditioning performance. Most preferably the average silicone particle size of the emulsified silicone in the composition is less than 2 microns, ideally it ranges from 0.01 to 1 micron. Silicone emulsions having an average silicone particle size of ≤ 0.15 microns are generally termed microemulsions.

Particle size may be measured by means of a laser light scattering technique, using a 2600D Particle Sizer from Malvern Instruments.

Suitable silicone emulsions for use in the invention are also commercially available in a pre-emulsified form.

Examples of suitable pre-formed emulsions include emulsions DC2-1766, DC2-1784, and microemulsions DC2-1865 and DC2-1870, all available from Dow Corning. These are all emulsions/microemulsions of dimethiconol. Cross-linked silicone gums are also available in a pre-emulsified form, which is advantageous for ease of formulation. A preferred example is the material available from Dow Corning as DC X2-1787, which is an emulsion of cross-linked dimethiconol gum. A further preferred example is the material available

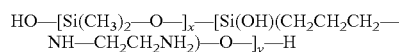
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from Dow Corning as DC X2-1391, which is a microemulsion of cross-linked dimethiconol gum.

A further preferred class of silicones for inclusion in conditioners of the invention are amino functional silicones. By "amino functional silicone" is meant a silicone containing at least one primary, secondary or tertiary amine group, or a quaternary ammonium group.

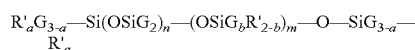
Examples of suitable amino functional silicones include:

(i) polysiloxanes having the CTFA designation "amodimethicone", and the general formula:



in which x and y are numbers depending on the molecular weight of the polymer, generally such that the molecular weight is between about 5,000 and 500,000.

(ii) polysiloxanes having the general formula:



in which:

G is selected from H, phenyl, OH or O_{1-8} alkyl, e.g. methyl; a is 0 or an integer from 1 to 3, preferably 0;

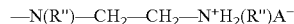
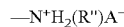
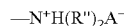
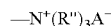
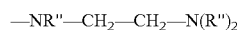
b is 0 or 1, preferably 1;

m and n are numbers such that (m+n) can range from 1 to 2000, preferably from 50 to 150;

m is a number from 1 to 2000, preferably from 1 to 10;

n is a number from 0 to 1999, preferably from 49 to 149, and

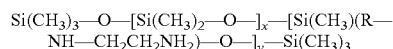
R' is a monovalent radical of formula $—\text{C}_q\text{H}_{2q}\text{L}$ in which q is a number from 2 to 8 and L is an aminofunctional group selected from the following:



in which R'' is selected from H, phenyl, benzyl, or a saturated monovalent hydrocarbon radical, e.g. C_{1-20} alkyl, and;

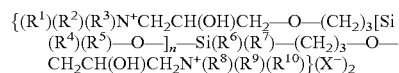
A is a halide ion, e.g. chloride or bromide.

Suitable amino functional silicones corresponding to the above formula include those polysiloxanes termed "trimethylsilylamodimethicone" as depicted below, and which are sufficiently water insoluble so as to be useful in compositions of the invention:



wherein x+y is a number from about 50 to about 500, and wherein R is an alkylene group having from 2 to 5 carbon atoms. Preferably, the number x+y is in the range of from about 100 to about 300.

(iii) quaternary silicone polymers having the general formula:



wherein R^1 and R^{10} may be the same or different and may be independently selected from H, saturated or unsaturated long or short chain alk(en)yl, branched chain alk(en)yl and C_5-C_8 cyclic ring systems;

R^2 thru' R^9 may be the same or different and may be independently selected from H, straight or branched chain lower alk(en)yl, and C_5-C_8 cyclic ring systems;

n is a number within the range of about 60 to about 120, preferably about 80, and

X⁻ is preferably acetate, but may instead be for example halide, organic carboxylate, organic sulphonate or the like.

Suitable quaternary silicone polymers of this class are described in EP-A-0 530 974.

Amino functional silicones suitable for use in conditioners of the invention will typically have a mole % amine functionality in the range of from about 0.1 to about 8.0 mole %, preferably from about 0.1 to about 5.0 mole %, most preferably from about 0.1 to about 2.0 mole %. In general the amine concentration should not exceed about 8.0 mole % since we have found that too high an amine concentration can be detrimental to total silicone deposition and therefore conditioning performance.

The viscosity of the amino functional silicone is not particularly critical and can suitably range from about 100 to about 500,000 cst.

Specific examples of amino functional silicones suitable for use in the invention are the aminosilicone oils DC2-8220, DC2-8166, DC2-8466, and DC2-8950-114 (all ex Dow Corning), and GE 1149-75, (ex General Electric Silicones).

Also suitable are emulsions of amino functional silicone oils with non ionic and/or cationic surfactant.

Suitably such pre-formed emulsions will have an average amino functional silicone particle size in the composition of less than 30, preferably less than 20, more preferably less than 10 microns. Again, we have found that reducing the particle size generally improves conditioning performance. Most preferably the average amino functional silicone particle size in the composition is less than 2 microns, ideally it ranges from 0.01 to 1 micron. Silicone emulsions having an average silicone particle size of ≤ 0.15 microns are generally termed microemulsions.

Pre-formed emulsions of amino functional silicone are also available from suppliers of silicone oils such as Dow Corning and General Electric. Specific examples include DC929 Cationic Emulsion, DC939 Cationic Emulsion, and the non-ionic emulsions DC2-7224, DC2-8467, DC2-8177 and DC2-8154 (all ex Dow Corning).

An example of a quaternary silicone polymer useful in the present invention is the material K3474, ex Goldschmidt.

The total amount of silicone incorporated into compositions of the invention depends on the level of conditioning desired and the material used. A preferred amount is from 0.01 to about 5% by weight of the total composition although these limits are not absolute. The lower limit is determined by the minimum level to achieve conditioning and the upper limit by the maximum level to avoid making the hair and/or skin unacceptably greasy.

We have found that a total amount of silicone of from 0.3 to 4%, preferably 0.5 to 3%, by weight of the total composition is a suitable level.

Other ingredients may include viscosity modifiers, preservatives, colouring agents, polyols such as glycerine and polypropylene glycol, chelating agents such as EDTA, antioxidants such as vitamin E acetate, fragrances, antimicrobials and sunscreens. Each of these ingredients will be present in an amount effective to accomplish its purpose. Generally these optional ingredients are included individually at a level of up to about 5% by weight of the total composition.

Preferably, compositions of this invention also contain adjuvants suitable for hair care. Generally such ingredients are included individually at a level of up to 2%, preferably up to 1%, by weight of the total composition.

Among suitable hair care adjuvants, are:

(i) natural hair root nutrients, such as amino acids and sugars.

Examples of suitable amino acids include arginine, cysteine, glutamine, glutamic acid, isoleucine, leucine, methionine, serine and valine, and/or precursors and derivatives thereof. The amino acids may be added singly, in mixtures, or in the form of peptides, e.g. di- and tripeptides. The amino acids may also be added in the form of a protein hydrolysate, such as a keratin or collagen hydrolysate. Suitable sugars are glucose, dextrose and fructose. These may be added singly or in the form of, e.g. fruit extracts.

(ii) hair fibre benefit agents. Examples are:

ceramides, for moisturising the fibre and maintaining cuticle integrity. Ceramides are available by extraction from natural sources, or as synthetic ceramides and pseudoceramides. A preferred ceramide is Ceramide II, ex Quest. Mixtures of ceramides may also be suitable, such as Ceramides LS, ex Laboratoires Serobiologiques.

free fatty acids, for cuticle repair and damage prevention. Examples are branched chain fatty acids such as 18-methylheicosanoic acid and other homologues of this series, straight chain fatty acids such as stearic, myristic and palmitic acids, and unsaturated fatty acids such as oleic acid, linoleic acid, linolenic acid and arachidonic acid. A preferred fatty acid is oleic acid. The fatty acids may be added singly, as mixtures, or in the form of blends derived from extracts of, e.g. lanolin.

Mixtures of any of the above active ingredients may also be used.

Preferably, the composition is a leave-on conditioning composition.

Preferably, the composition of the invention has a pH of from 2 to 6, more preferably, from 3 to 5.

In a second aspect there is provided the use of a composition according to any preceding claim for conditioning the hair.

EXAMPLE 1

Ingredient	% wt.
Water	To 100
Lactic acid	0.1
Stearamidopropyl dimethylamine	1.0
Fatty alcohol	3.0
Preservative	0.2
Mineral oil	3.0
Dimethicone	2.0
PQ-37 and acrylamide**	0.25
Glycerine	2.0
MQ resin	0.4

* Tinovis CD ex. BASF

EXAMPLE 2

Ingredient	% wt.
Water	To 100
Lactic acid	0.1
Stearamidopropyl dimethylamine	1.0
Fatty alcohol	3.0
Preservative	0.2
Mineral oil	3.0
Dimethicone	2.0

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-continued

Ingredient	% wt.
Copolymer of methacryloyloxyethyltrialkylammonium salt and PEG methacrylate*	0.25
Glycerine	2.0
MQ resin	0.4

*The crosslinked copolymer is in inverse emulsion form, methacryloyloxyethyltrialkylammonium salt and PEG methacrylate represent respectively 98 mol % 2 mol % of the total amount of these two monomers.

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Results - Natural PQ-37 and acrylate			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s-1
316.120	173.340	0.548	1.724
562.140	228.750	0.407	1.279
999.660	317.960	0.318	1.000

EXAMPLE 3

Study of Combing Cream Formulations Under Low pH Conditions

Formulations according to Examples 1 and 2 were pH adjusted using Lactic Acid to achieve set target pH values of 5.5, 5.0, 4.5, 4.0, 3.5 and 3.0 (all +/-0.15 pH units). Natural pH was used as the control

Rheology measurements were all conducted using a Bohlin C-VOR rheometer fitted with a serrated cup and bob geometry (C14 DIN 53019). Range of shear rate employed was from 0.001 s⁻¹-1000 s⁻¹. Measurements were carried out at 25° C.

The gap between the tips of the cup and bob serrations was 700 µm and the measurements were made in 'controlled rate' mode (stress is continuously adjusted to achieve an actual shear rate that is close to the target shear rate).

No pre-shear was applied to the samples with the shear rate being cycled (Up-Down-Up) in logarithmic steps with 8 pts per decade (Purpose of cycling is to check for any irreversible shear induced changes).

Data was taken from the 2nd 'Up' Cycle to ensure a consistent baseline.

Shear Rate vs Normalised Viscosity and Shear-Stress vs Normalised Viscosity plots were generated to compare the samples rheological behaviour.

EXAMPLE 4

Results - Natural PQ-37 and acrylate			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s-1
0.001	13.047	13045.000	41012.985
0.002	22.902	12884.000	40506.807
0.003	33.328	10540.000	33137.360
0.006	42.199	7507.100	23602.037
0.010	47.850	4786.400	15048.260
0.018	50.778	2856.200	8979.784
0.032	50.963	1612.200	5068.696
0.056	51.450	915.390	2877.951
0.100	52.668	526.940	1656.679
0.178	54.256	305.230	959.632
0.316	56.229	177.880	559.248
0.562	58.259	103.640	325.840
1.000	60.364	60.385	189.848
1.777	62.619	35.228	110.755
3.161	65.479	20.716	65.130
5.621	69.129	12.298	38.664
9.997	74.044	7.407	23.287
17.777	80.910	4.552	14.310
31.611	90.040	2.848	8.955
56.207	102.700	1.827	5.745
99.950	119.540	1.196	3.760
177.750	142.570	0.802	2.522

Natural PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s-1
0.001	10.678	10671.000	41644.552
0.002	20.973	11792.000	46019.357
0.003	22.385	7081.400	27635.810
0.006	21.753	3870.000	15103.028
0.010	21.861	2186.800	8534.187
0.018	22.096	1243.000	4850.921
0.032	22.532	712.820	2781.845
0.056	23.277	414.080	1615.985
0.100	24.339	243.510	950.320
0.178	25.910	145.760	568.842
0.316	28.024	88.652	345.973
0.562	30.499	54.255	211.735
1.000	33.014	33.028	128.895
1.777	35.913	20.205	78.852
3.161	39.215	12.407	48.419
5.621	43.421	7.724	30.145
9.996	48.964	4.898	19.116
17.777	55.880	3.143	12.267
31.612	64.889	2.053	8.011
56.207	77.532	1.379	5.383
99.950	93.462	0.935	3.649
177.750	114.110	0.642	2.505
316.100	144.170	0.456	1.780
562.110	192.000	0.342	1.333
999.640	256.150	0.256	1.000

pH 5.5 PQ-37 and acrylate			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s-1
0.001	9.571	9562.200	41836.717
0.002	18.855	10602.000	46386.069
0.003	23.053	7291.700	31902.783
0.006	23.555	4190.700	18335.229
0.010	24.125	2413.600	10560.028
0.018	24.829	1396.800	6111.306
0.032	25.788	815.770	3569.172
0.056	26.921	478.950	2095.511
0.100	28.306	283.200	1239.062
0.178	29.948	168.480	737.137
0.316	31.767	100.490	439.666
0.562	33.748	60.035	262.666
1.000	35.862	35.875	156.961
1.777	38.447	21.631	94.640
3.161	41.499	13.129	57.442
5.621	45.375	8.072	35.317
9.996	50.371	5.039	22.046
17.777	56.807	3.196	13.981
31.612	65.164	2.061	9.019
56.211	76.732	1.365	5.973
99.950	91.197	0.912	3.992
177.750	111.600	0.628	2.747
316.120	143.760	0.455	1.990
562.120	177.410	0.316	1.381
999.640	228.480	0.229	1.000

pH 5.5 PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	3.932	3933.900	23505.617
0.002	7.129	4010.200	23961.520
0.003	7.612	2408.400	14390.535
0.006	7.813	1389.900	8304.852
0.010	8.085	808.820	4832.815
0.018	8.440	474.790	2836.938
0.032	8.869	280.570	1676.446
0.056	9.412	167.450	1000.538
0.100	10.087	100.920	603.011
0.178	10.933	61.506	367.507
0.316	11.939	37.766	225.657
0.562	13.143	23.380	139.699
1.000	14.566	14.571	87.064
1.778	16.260	9.148	54.658
3.161	18.205	5.759	34.413
5.621	20.660	3.676	21.962
9.996	23.772	2.378	14.209
17.776	27.886	1.569	9.373
31.612	33.409	1.057	6.315
56.207	41.352	0.736	4.396
99.950	51.958	0.520	3.106
177.750	65.827	0.370	2.213
316.120	92.591	0.293	1.750
562.120	118.800	0.211	1.263
999.640	167.300	0.167	1.000

pH 5.0 PQ-37 and acrylate			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	2.575	2581.200	37363.751
0.002	5.559	3119.600	45157.275
0.003	7.277	2304.900	33364.214
0.006	6.829	1214.400	17578.854
0.010	6.668	666.980	9654.763
0.018	6.177	347.480	5029.892
0.032	6.618	209.380	3030.847
0.056	6.257	111.300	1611.105
0.100	6.148	61.509	890.364
0.178	6.402	36.017	521.358
0.316	6.705	21.211	307.036
0.562	7.005	12.462	180.392
1.000	7.289	7.292	105.553
1.777	7.856	4.420	63.981
3.161	8.494	2.687	38.898
5.621	9.371	1.667	24.130
9.997	11.067	1.107	16.026
17.776	12.666	0.713	10.314
31.612	14.029	0.444	6.424
56.207	18.649	0.332	4.803
99.950	21.743	0.218	3.149
177.750	26.168	0.147	2.131
316.100	37.016	0.117	1.695
562.150	48.760	0.087	1.256
999.660	69.059	0.069	1.000

pH 5.0 PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	7.842	7850.500	38224.267
0.002	15.493	8711.500	42416.496
0.003	19.161	6061.800	29515.045
0.006	19.731	3510.100	17090.759
0.010	20.326	2033.100	9899.211
0.018	21.064	1184.900	5769.306
0.032	21.911	693.180	3375.110

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pH 5.0 PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.056	22.938	408.070	1986.902
0.100	24.192	242.040	1178.498
0.178	25.659	144.350	702.844
0.316	27.353	86.528	421.307
0.562	29.198	51.941	252.902
1.000	31.249	31.262	152.215
1.777	33.590	18.897	92.010
3.161	36.514	11.552	56.247
5.621	39.960	7.109	34.613
9.997	44.638	4.465	21.742
17.776	50.358	2.833	13.793
31.612	58.171	1.840	8.960
56.207	68.587	1.220	5.942
99.950	82.688	0.827	4.028
177.750	100.630	0.566	2.756
316.100	134.990	0.427	2.079
562.150	160.310	0.285	1.389
999.660	205.310	0.205	1.000

pH 4.5 PQ-37 and acrylate			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	7.579	7571.600	34505.765
0.002	15.080	8485.200	38669.279
0.003	18.681	5910.700	26936.608
0.006	19.413	3453.500	15738.504
0.010	20.080	2008.700	9154.172
0.018	20.854	1173.200	5346.580
0.032	21.766	688.550	3137.903
0.056	22.852	406.570	1852.846
0.100	24.160	241.720	1101.581
0.178	25.694	144.550	658.752
0.316	27.433	86.785	395.502
0.562	29.295	52.113	237.493
1.000	31.362	31.373	142.975
1.777	33.533	18.866	85.977
3.161	35.924	11.365	51.793
5.621	39.422	7.013	31.961
9.996	44.229	4.425	20.165
17.777	50.317	2.831	12.899
31.610	59.352	1.878	8.557
56.207	69.492	1.236	5.635
99.950	84.282	0.843	3.843
177.750	103.870	0.584	2.663
316.120	131.070	0.415	1.889
562.150	167.020	0.297	1.354
999.640	219.350	0.219	1.000

pH 4.5 PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	3.758	3757.700	22084.631
0.002	6.785	3819.300	22446.665
0.003	7.223	2286.700	13439.318
0.006	7.401	1316.900	7739.641
0.010	7.758	775.910	4560.153
0.018	8.094	455.300	2675.874
0.032	8.449	267.250	1570.673
0.056	9.032	160.670	944.284
0.100	9.690	96.947	569.774
0.178	10.554	59.374	348.951
0.316	11.574	36.616	215.198
0.562	12.831	22.824	134.140
1.000	14.229	14.235	83.661

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pH 4.5 PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
1.777	15.963	8.981	52.783
3.161	17.853	5.648	33.196
5.621	20.230	3.599	21.151
9.996	23.414	2.342	13.766
17.777	27.520	1.548	9.098
31.612	33.192	1.050	6.171
56.207	41.052	0.730	4.292
99.950	51.860	0.519	3.049
177.750	66.470	0.374	2.198
316.120	83.256	0.263	1.548
562.110	125.050	0.222	1.307
999.640	170.090	0.170	1.000

pH 4.0 PQ-37 and acrylate			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	7.753	7752.000	35186.782
0.002	15.227	8565.500	38879.306
0.003	18.501	5852.300	26563.933
0.006	19.118	3400.100	15433.253
0.010	19.779	1978.500	8980.527
0.018	20.599	1158.700	5259.407
0.032	21.511	680.500	3088.829
0.056	22.609	402.230	1825.746
0.100	24.003	240.130	1089.964
0.178	25.607	144.060	653.897
0.316	27.505	87.013	394.957
0.562	29.701	52.838	239.835
1.000	32.004	32.017	145.327
1.778	34.620	19.476	88.403
3.161	37.700	11.927	54.137
5.621	41.485	7.380	33.499
9.997	46.487	4.650	21.108
17.777	52.807	2.971	13.484
31.612	61.133	1.934	8.778
56.207	72.415	1.288	5.848
99.950	87.157	0.872	3.958
177.750	106.830	0.601	2.728
316.100	142.040	0.449	2.040
562.150	169.090	0.301	1.365
999.640	220.230	0.220	1.000

pH 4.0 PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	2.975	2972.900	17833.833
0.002	5.376	3026.600	18155.969
0.003	5.612	1775.900	10653.269
0.006	5.756	1024.400	6145.171
0.010	5.970	597.190	3582.424
0.018	6.217	349.740	2098.020
0.032	6.542	206.940	1241.392
0.056	6.974	124.070	744.271
0.100	7.513	75.157	450.852
0.178	8.231	46.302	277.756
0.316	9.146	28.933	173.563
0.562	10.317	18.355	110.108
1.000	11.760	11.765	70.576
1.778	13.523	7.608	45.638
3.161	15.399	4.872	29.226
5.621	17.730	3.154	18.921
9.996	20.667	2.068	12.403
17.776	24.487	1.378	8.263
31.612	29.985	0.949	5.690

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pH 4.0 PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
56.207	38.970	0.693	4.159
99.950	49.764	0.498	2.987
177.750	63.835	0.359	2.154
316.120	91.541	0.290	1.737
562.150	130.330	0.232	1.391

pH 3.5 PQ-37 and acrylate			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	7.731	7723.200	34381.872
0.002	15.227	8564.500	38127.142
0.003	18.386	5816.400	25893.247
0.006	19.067	3392.100	15100.832
0.010	19.754	1976.200	8797.578
0.018	20.563	1156.700	5149.357
0.032	21.451	678.610	3021.012
0.056	22.563	401.420	1787.028
0.100	23.931	239.420	1065.842
0.178	25.506	143.490	638.784
0.316	27.350	86.523	385.180
0.562	29.360	52.228	232.507
1.000	31.528	31.540	140.409
1.777	34.026	19.144	85.225
3.161	36.949	11.689	52.037
5.621	40.711	7.243	32.242
9.996	45.649	4.567	20.330
17.777	51.678	2.907	12.942
31.612	59.979	1.897	8.447
56.207	71.348	1.269	5.651
99.950	86.330	0.864	3.845
177.750	106.240	0.598	2.661
316.100	136.750	0.433	1.926
562.150	173.290	0.308	1.372
999.640	224.550	0.225	1.000

pH 3.5 PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	3.171	3167.800	20175.785
0.002	5.632	3163.400	20147.761
0.003	5.880	1858.300	11835.552
0.006	6.029	1072.100	6828.228
0.010	6.262	626.550	3990.510
0.018	6.541	368.010	2343.863
0.032	6.937	219.430	1397.554
0.056	7.357	130.900	833.705
0.100	8.023	80.266	511.216
0.178	8.790	49.448	314.935
0.316	9.768	30.899	196.796
0.562	10.880	19.354	123.266
1.000	12.196	12.201	77.708
1.777	13.635	7.671	48.859
3.161	15.448	4.887	31.126
5.621	17.765	3.160	20.128
9.996	20.576	2.059	13.111
17.777	24.468	1.376	8.766
31.612	29.124	0.921	5.868
56.207	36.397	0.648	4.124
99.950	46.255	0.463	2.947
177.750	58.382	0.328	2.092
316.120	87.204	0.276	1.757
562.150	106.770	0.190	1.210
999.640	156.950	0.157	1.000

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pH 3.0 PQ-37 and acrylate			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	6.410	6409.700	33602.621
0.002	12.218	6872.000	36026.212
0.003	14.156	4478.700	23479.423
0.006	14.690	2613.100	13699.083
0.010	15.247	1525.300	7996.330
0.018	15.901	894.500	4689.384
0.032	16.531	522.930	2741.442
0.056	17.382	309.220	1621.075
0.100	18.397	184.050	964.875
0.178	19.726	110.970	581.756
0.316	21.296	67.372	353.195
0.562	23.026	40.960	214.731
1.000	24.889	24.899	130.532
1.777	26.818	15.088	79.098
3.161	29.318	9.276	48.628
5.621	32.534	5.788	30.342
9.997	36.565	3.658	19.175
17.776	42.227	2.376	12.453
31.610	49.042	1.552	8.134
56.207	59.089	1.051	5.511
99.950	71.575	0.716	3.754
177.750	88.755	0.499	2.618
316.100	123.040	0.389	2.041
562.150	146.070	0.260	1.362
999.660	190.680	0.191	1.000

pH 3.0 PQ-37 and acrylamide			
Shear Rate (1/s)	Shear Stress (Pa)	Viscosity (Pas)	Visc/Visc@1000 s ⁻¹
0.001	2.056	2058.600	16859.951
0.002	3.656	2056.700	16844.390
0.003	3.910	1237.100	10131.859
0.006	4.033	717.620	5877.314
0.010	4.232	423.360	3467.322
0.018	4.417	248.460	2034.889
0.032	4.630	146.490	1199.754
0.056	4.938	87.847	719.468
0.100	5.317	53.199	435.700
0.178	5.819	32.733	268.084
0.316	6.434	20.354	166.699
0.562	7.214	12.833	105.102
1.000	8.150	8.153	66.776
1.777	9.261	5.211	42.675
3.161	10.632	3.364	27.549
5.621	12.255	2.180	17.856
9.997	14.437	1.444	11.828
17.777	17.369	0.977	8.002
31.612	21.193	0.670	5.491
56.207	27.490	0.489	4.006
99.950	34.313	0.343	2.812
177.750	43.495	0.245	2.004
316.100	55.938	0.177	1.449
562.110	84.262	0.150	1.228
999.640	122.060	0.122	1.000

CONCLUSIONS

There is a clear benefit displayed from the PQ-37/acrylate copolymer over PQ-37/acrylamide copolymer (Tinovis CD) in all aspects of studied rheology

Yield Stress is increased even when electrolyte is introduced by lowering the pH of the system.

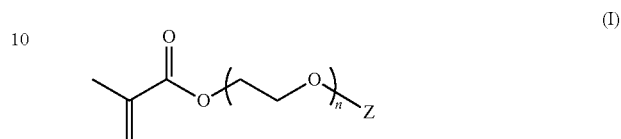
Basic Shear profiles are maintained with some slight directional increase for the PQ-37/acrylate polymer.

The invention claimed is:

1. A hair treatment composition comprising a fatty alcohol-containing lamellar phase, an acid neutralized amidoamine

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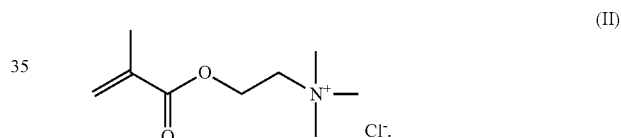
surfactant, and a thickener which comprises a co-polymer derived from the polymerization of at least a non-ionic monomer (a) and at least a cationic monomer (b) and crosslinked, wherein the non-ionic monomer (a) is a poly(ethylene glycol) methacrylate of the following structure corresponding to Formula I:



n is from 1 to 250 and Z is H or an alkyl group with 1 to 5 carbon atoms and wherein the cationic monomer (b) is a methacryloyloxyethyltrialkylammonium, quaternized or salified, wherein the cationic monomer represents from 85 to 99.9 mol% of the co-polymer, without taking into account any crosslinking agent or chain transfer agent that may be used in the polymerization, and wherein the hair treatment composition has a pH of from 2 to 6 and is in the form of a leave-on hair conditioner that contains no anionic surfactant.

2. Composition according to claim 1 wherein the non-ionic monomer (a) is poly(ethylene glycol) methacrylate.

3. Composition according to claim 1 wherein the cationic monomer (b) is methacryloyloxyethyltrialkylammonium salt of the following formula (II)



4. Composition according to claim 1 wherein the non-ionic monomer (a) represents the balance of the mol % of the polymer, without taking into account the crosslinking agent or the chain transfer agent.

5. Composition according to claim 1 wherein the copolymer is crosslinked with 50 to 5,000 ppm by weight of crosslinking agent based on the total amount of cationic and non-ionic monomers.

6. Composition according to claim 5 wherein the crosslinking agent is selected from the group comprising methylene bisacrylamide (MBA), ethylene glycol diacrylate, polyethylene glycol dimethacrylate, diacrylamide, cyanomethylacrylate, vi nyloxyethylacrylate or methacrylate, triallylamine, formaldehyde, glyoxal, compounds of the glycidylether type and epoxy.

7. Composition according to claim 1 wherein the co-polymer is added to the composition in the form of an inverse emulsion made by reverse phase polymerisation.

8. Composition according to claim 7 wherein the inverse emulsion is concentrated by heating under vacuum to remove excess water and organic solvent by distillation.

9. Composition according to claim 1 comprising from 0.01 to 5% wt. of the composition of said thickener.

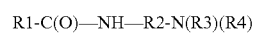
10. The composition according to claim 1 wherein the fatty alcohol is present in an amount of 0.01 to 5% by weight of the composition.

11. The composition according to claim 1 wherein the fatty alcohol comprises from 8 to 22 carbon atoms.

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12. The composition according to claim **1** wherein the fatty alcohol comprises cetyl and/or stearyl alcohol.

13. The composition according to claim **1** wherein the acid neutralized amidoamine surfactant is of general formula:



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wherein R1 is a fatty acid chain with from 12 to 22 carbon atoms, R2 is an alkylene group containing from one to 4 carbon atoms and R3 and R4 are, independently, an alkyl group having from one to four carbon atoms.

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14. The composition of claim **1** further comprising a conditioning silicone.

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